

CLAIMS

1. A process for co-producing high purity para-xylene and styrene, from a feed containing xylenes, ethylbenzene and C9-C10 hydrocarbons, the process comprising the following steps in succession:
 - a step for distilling the feed (1) carried out in a distillation column (2) to separate the xylenes, from which an overhead stream (3) comprising the major portion of the meta-xylene, para-xylene, ethylbenzene and at least a portion of the ortho-xylene is withdrawn overhead, and from which a stream (4) containing C9-C10 hydrocarbons and the remainder of the ortho-xylene is extracted from the bottom;
 - a step for adsorption of the overhead stream (3) in at least one first adsorption column (6) operating as a simulated moving bed and containing a plurality of beds of an adsorbent, preferably interconnected in a closed loop, and having a different selectivity for para-xylene, ethylbenzene, meta-xylene and ortho-xylene, said column comprising at least four operational zones: a zone 1 for desorbing para-xylene located between the point for injection of a desorbant (5) and that for removing an extract (7a); a zone 2 for desorbing ethylbenzene, ortho-xylene and meta-xylene located between the extract (7a) removal point and that for injection of the adsorption feed (3); a zone 3 for adsorption of para-xylene located between the point for injection of the feed (3) and that for withdrawing a raffinate (7b); and a zone 4 located between the point for withdrawing the raffinate (7b) and that for injection of the desorbant (5);
 - a step for distilling the extract (7a) carried out in at least one distillation column (8a), from which pure para-xylene (9a), preferably at least 99.7% by weight pure, is withdrawn from said column (8a), and from which desorbant is withdrawn from said column and at least partially recycled to the first adsorption column;

- a step for distilling the raffinate (7b) in at least one distillation column (8b) and withdrawing desorbant from the column at least a portion of which is recycled to the first adsorption column, and withdrawing from the column a distilled raffinate (9b) containing meta-xylene, ortho-xylene and ethylbenzene;
 - a step for dehydrogenating the distilled raffinate comprising ethylbenzene to obtain an effluent containing styrene, meta-xylene, ortho-xylene, unconverted ethylbenzene and by-products, carried out in at least one dehydrogenation zone (10), during which at least 50% by weight of the ethylbenzene introduced is converted into styrene;
 - at least one step for eliminating by-products in at least one distillation column to produce a mixture (18) containing a majority of styrene, ethylbenzene, meta-xylene and ortho-xylene;
 - a step for separating the mixture (18) and withdrawing from said step a first stream (23a) containing at least 99.8% by weight pure styrene and a second stream (23b) containing the majority of meta-xylene and ortho-xylene;
 - a step for isomerising the second stream (23b) in a unit (24), preferably in the liquid phase, in at least one isomerisation zone, from which para-xylene (25), ortho-xylene and meta-xylene are recovered and recycled upstream of the feed distillation column (2).
2. A process according to claim 1, in which the step for separating the mixture (18) is carried out in at least one second adsorption column (20) operating as a simulated moving bed, containing a plurality of beds of an adsorbent, preferably interconnected in a closed loop and having a different selectivity for styrene, ethylbenzene, meta-xylene and ortho-xylene, said column (20) comprising at least four chromatographic zones: a first zone, for styrene desorption, located between the point for injecting a

desorbant (19) and that for removing an extract (21a); a second zone, for desorption of ethylbenzene, meta-xylene and ortho-xylene, located between the point for removing the extract (21a) and that for injecting an adsorption feed comprising said mixture (18); a third zone, for styrene adsorption, located between the point for injecting the feed (18) and that for removing a raffinate (21b); and a fourth zone located between the point for removing the raffinate (21b) and that for injecting desorbant (19).

3. A process according to claim 1 or claim 2, in which the extract is distilled to eliminate the desorbant, the raffinate is distilled to eliminate the desorbant, and at least a portion of the recovered desorbant is recycled to the second adsorption column.
4. A process according to any one of claims 1 to 3, in which the first adsorption column (6) is operated in five functional zones, a first raffinate (7b) that is enriched in ethylbenzene is withdrawn from said column, and a second raffinate (7c) is withdrawn between the point for withdrawing the first raffinate (7b) and the point for injecting desorbant (5), said adsorption column (6) then being characterized in that it comprises: said functional zones 1 and 2 of the first adsorbent column (6), a zone 3A for adsorbing para-xylene between the point for injecting the feed and the point for withdrawing the first raffinate; a zone 3B for adsorbing ethylbenzene located between the point for withdrawing the first raffinate and the point for withdrawing the second raffinate; a zone 4 located between the point for withdrawing the second raffinate and the point for injecting desorbant.
5. A process according to claim 4, in which the first raffinate (7b) is distilled in a distillation column (8b) to eliminate substantially all of the desorbant, the first distilled raffinate (9b) then being sent to the dehydrogenation zone (10), and the

second raffinate (7c) then being distilled in a distillation column (8c) to eliminate substantially all of the desorbant, the second distilled raffinate (9c) which is recovered that is substantially free of ethylbenzene then being directed to the isomerisation zone.

6. A process according to one of claims 1 to 5, in which the adsorbent used in the first adsorption column is an X zeolite exchanged with barium or a Y zeolite exchanged with potassium, or a Y zeolite exchanged with barium and potassium.
7. A process according to any one of claims 2 to 6, in which the adsorbent used in the second adsorption column is an X or Y zeolite exchanged with sodium or barium or potassium or lithium, also potassium or silver.
8. A process according to one of claims 1 to 7, in which the desorbant for the first adsorption column is selected from the group constituted by paradiethylbenzene, toluene, para-difluorobenzene and diethylbenzenes as a mixture.
9. A process according to any one of claims 2 to 8, in which the desorbant for the second adsorption column is selected from the group constituted by toluene, naphthalene and its alkylated derivatives.
10. A process according to one of claims 2 to 9, in which the volume ratio of desorbant to feed for the first adsorption column is in the range 0.5 to 2.5, preferably in the range 1.4 to 1.7, and the volume ratio of desorbant to feed for the second adsorption column is in the range 0.5 to 3.0, preferably in the range 1.4 to 2.0.
11. A process according to one of claims 1 to 10, in which the first adsorption step is carried out at a temperature in the range 20°C to 250°C, preferably in the range 90°C to 210°C and more preferably in the range 160°C to 200°C and at a pressure in the range from the bubble point pressure of xylenes at the operating temperature and 2 MPa.

12. A process according to one of claims 2 to 11, in which the second adsorption column is operated at a temperature in the range 20°C to 200°C, preferably in the range 50°C to 150°C, and more preferably in the range 60°C to 100°C, and at a pressure in the range from the bubble point pressure of the mixture at the operating temperature and 2 MPa.
13. A process according to one of claims 4 to 12, in which the first adsorption column contains at least 24 beds, at least 3 beds of which are in zone 3B.
14. A process according to one of claims 2 to 13, in which the second adsorption column contains at least 16 beds, at least 5 beds of which are in the second zone.
15. A process according to one of claims 1 to 14, in which the fraction (9a) is enriched in para-xylene, at at least 50% purity, and is sent to at least one crystallization zone to produce para-xylene crystals and a mother liquor, the crystals being separated from the mother liquor, optionally taken up into suspension, washed and recovered, and the mother liquor is recycled to the first separation column.
16. A process according to one of claims 1 to 15, in which the distillation column (2) is operated so that at least a portion of a fraction containing ortho-xylene is withdrawn from the column bottom, said fraction also containing aromatics containing at least 9 carbon atoms is sent to a distillation column so that an overhead stream of ortho-xylene with a purity of at least 98.5% by weight is withdrawn, and a stream containing aromatics containing at least 9 carbon atoms and possibly ortho-xylene is withdrawn from the column bottom.
17. A process according to claim 1, in which the step for separating the mixture (18) employs a separation technique selected from the group constituted by distillation, azeotropic distillation, extractive distillation, liquid-liquid extraction, formation of a chemical complex, membrane separation and a combination thereof.

18. A process according to one of claims 1 to 17, in which the second stream (23b) further contains styrene; said stream is hydrogenated in a hydrogenation zone, and a hydrogenation effluent is recovered and sent to the isomerisation zone.
19. A process according to one of claims 1 to 18, in which the second stream (23b) contains at most 10% by weight of ethylbenzene, preferably at most 5% by weight of ethylbenzene.